GUIDE TO THE COMPUTER PRODUCTION OF RANDOMIZED EXAMINATIONS

N. A. Frigerio and R. S. Stowe

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Environmental Statement Project
Argonne National Laboratory
Argonne, Illinois 60439

and

National College of Chiropractic Medicine
Lombard, Illinois 60148

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Section 1, Introduction:

With increasing crowding of classrooms and increased teaching loads, it becomes evermore difficult for the instructor to provide examinations which obviate the possibility of student transcription, and which are not too similar to previous examinations possibly in circulation, without going to forms which are either very difficult to write or difficult to grade. To aid some in this area, we have produced a program for randomizing objective type examinations,⁶ which is now in use in several nearby schools. This program is designed to minimize labor on the part of the instructor, both in preparation and in correction, while at the same time designing examinations so that breaches of security are rendered difficult. The program has been kept small enough to be used at schools with even the most modest computer facilities.

We have avoided the common five-part examination because these are notoriously difficult to write, and often require considerable screening before five appropriate answers can be chosen.³ Instead, we have gone to the "choice from a list" type of examination because, with any reasonable sized list of answers, the problem of random selection of correct answers essentially vanishes. It is also possible to render this type of examination random in many of its features, so that each student receives a copy peculiar to him, even though the material covered is the same. At the same time, it makes it possible for the instructor to write such an examination easily, and to have it corrected with equal ease.

In brief, the instructor simply writes down, in straight text, the material which he wishes to cover. He then returns and circles those key words which he wishes to have extracted, and to be understood as answers in context. At the same time he indicates, on a separate line, the number of copies he desires, the number of questions contained in the text, and the number of master copies he wishes to receive. The master copies contain his original text with the questions and answers printed in full, so that he can rapidly check questions against answers. He also indicates whether he wishes the number sequence of questions to be scrambled, and whether, and how, he wishes the text to be scrambled. Finally, he selects two code numbers, known only to himself, which govern the scrambling of answer codes and student codes. These scramblings utilize a random number generator of known randomness⁴ which is always available in its entirety to the instructor, but which is controlled in its output entirely by the key numbers which he employs. This information is then conveyed to the data center, which punches up the appropriate cards, and the resultant master copies and student copies are given back to the instructor.

An example of such a quiz is shown in Figure 1. In this particular example, both the sequence of questions numbered within the text, and various sentences of the text, are scrambled from one student's copy to another. The answer list, however, remains the same. We normally list it in alphabetical order so as to facilitate the students location of the correct answer with a minimum of clerical time.

The first two lines contain instructions to the student and, at the far right, an examination identifier to be used during corrections (as described)

below). The second line contains the title of the examination, the date, and the student's name, as well as the student's code number, printed twice. On the left hand section of the page is the text, with the missing words or phrases indicated by two pairs of asterisks, with the question number between them. The answer list follows to the right. After each answer is a random answer code which is unique not only for that answer but also for the particular student. Thus, a student transcribing one of these codes from a neighbor would not only invariably have an incorrect answer, but one from which the computer could always determine, by rechecking the random number sequence, the student from whom he had transcribed it.

Space for the answer then follows to the right and, on the far right, are listed the correct answer codes corresponding to these questions. In use, this strip to the far right is removed with a paper cutter and saved for the corrector. At the head of each strip is the indicator which identifies the examination, so that a corrector who has many different examinations from many different courses will not be in confusion. This is followed by the student code number, which must match the student code number of a student's own sheet. During hand correction, the corrector simply aligns this strip with the student's answer strip, moves vertically down the column to correct them, determines the grade, and records it. Recording and processing of grades may also be computerized, if desired, using a system described elsewhere.²

The format shown here is only one of a large number of options available to the instructor, and different arrangements may be elected. Also, if the instructor has an appropriate list of students' names, these may be inserted

automatically from a list given to the data center, if so desired. Thus, during the term, there will always be a unique relationship between the student's code and the student's name. This relationship is under the control of the instructor, however, and need be known only by him if he so desires, e. g. it may be changed from quiz to quiz without loss of information.

This kind of quiz may also make reference to external material, e. g. graphs or tables handed out as reproduced sheets, or drawn on the blackboard. Examples of this are included in Figure 1. In addition, if the instructor desires that a particular numerical answer be calculated by the student and entered, this is also feasible. In this case, the random number code is replaced by the correct numerical answer on the corrector's strip and by a blank, plus the legend "numerical answer", on the student's copy of the same.

We have found, over the course of the last several years, that students adapt to this type of examination very quickly. Invariably, they master its clerical aspects within one, or at most two, practice sessions.

The student, as he takes the examination, simply identifies the question number to be supplied with the appropriate word or phrase, locates the correct word or phrase in the list, and copies its code into the blanks that correspond to that question number.

If the quiz is relatively unscrambled, i. e. the question numbers begin with one and run through linearly to the end, we have found that the clerical

time involved in matching answer to question is about six minutes, if the student knows all the answers. This was tested by giving students an examination, correcting it and returning it to them. They were then informed, a week later, that they would receive the same examination over again, and that they were to fill it out as quickly as they could. However, because the answer codes are random numbers, the answer codes themselves would not be the same on the two successive examinations. Thus, it was necessary for them to actually locate the answer and copy down its new code; i. e. it was not possible simply to copy the codes from the old quiz directly down the column. When the questions were more scrambled, i. e. the numbers of the questions were not in simple linear order, the average clerical time involved was about nine minutes. We generally allow one minute per question, so that this investiture of about 0.15 minute in clerical time per question compares favorably with the amount of clerical time involved in the more common five-part examination.³

The particular example given is from a pathology course in Neoplasms. However, we have utilized similar examinations for courses in clinical genetics, physiology, infectious diseases, nutrition, biophysics, radiation biology, and biochemistry. In all cases, student acceptance was extremely high, and complaints of misgrading or misunderstanding averaged something less than 1/2 percent. At the same time it permitted us to administer quizzes at least once a week, in each of a number of courses, to student groups ranging from 30 to 120 per course.

Clearly, some security must be maintained over copies of the examination before it is given, since it does clearly outline the material that will be covered. However, even possession of a master copy during the examination itself

would avail the student relatively little because of the difficulty of translating the random order of his own copy into that of the master copy.

Thus, we have found this type of examination to offer marked advantages, in terms of ease of grading and make-up for the instructor, as well as relatively less stringent requirements on examination security than is often necessary with other sorts of examinations. Although the examples shown here are graded by hand, it is possible to adapt the same type of examination easily to standard computerized grading forms of the type possessed by some educational institutions or to IBM Port-a-Punch systems.²

Section 2, The Program:

A complete program and data listing is presented in Figure 2. Each list entry corresponds to one card, and each such card has been given a card number at the far left.

Card 1: Place the job control cards particular to the data center in use.

Cards 2-21: Comment cards briefly explaining the input and its format.

Cards 22-25: Logical 1 declaration and dimension statements. Since most of the input data is of single byte characters, Logical *1 reduces the needed program space.

Cards 26-46: Format statements used in reading data, and printing output.

Card 48: Instruction to read into the computer the symbols used for numerals, *, %, -, and blank. By reading these, they will be automatically converted to the machine representation particular to the computer being used.

Cards 49-63: Clear storage spaces reserved for variables to be read from the data set.

Cards 68-80: Read examination title, control card, text, answers, and the list of student names, if used.

Cards 81-100: Master copies are organized and printed.

Cards 101-108: Advances random number generator by the value of NSR.

Cards 109-121: Locates %% points indicated by instructor, as starting points for text scrambling, then blanksout the %% from the text.

Cards 122-135: Locates the positions of the question numbers in the text and stores their locations.

Cards 136-148: The locations of %% and **, and the locations and values of numerical answers, are printed for instructor reference.

Cards 149-233: Assemble and print tests.

Cards 156-175: Questions are renumbered for each test unless inhibited by JN read at card 69.

Cards 176-196: Text is shifted ("scrambled") unless inhibited by JT read at card 69.

Cards 197-233: Test is printed, along with instructions to students, test title, student name (or blank for name), text, and answer

choice list. Correct answer strip is printed at far right, headed by test identifiers.

Program then recycles to card 149 to process and print next test. When NSTUD tests have been printed, program exits at 235.

A flow diagram is presented in Figure 3 keyed to the card numbers of the listing in Figure 2.

Section 3, Input Data:

Card 237: Job control cards as required by local data center.

Card 238: The standard symbol list. Variables are named and listed, with their dimension in parentheses if >1.

MM(10) = the number symbols, 0-9.

LSF1 = symbol to identify question numbers, usually *.

NB = the blank symbol.

LSF2 = symbol to identify the start of a text scramble section,
usually %.

LD(5) = string of five dashes for answers.

Format is A1, i.e., one column per symbol.

Card 239: Used to enter examination title and identifiers to appear above correction strips.

LP(40) = Exam title, 40A1, i.e. the first 40 columns are referred
for title.

LE(12) = Identifiers. These are grouped into two lines of six characters each when printed. Thus, columns 41-46 and 47-52 will be printed as two identifiers above one another over the correction strip. Format 12A1.

Card 240: Enters copy and scramble control.

NSTUD = Number of copies desired, 15 in the example.

NQS = Number of questions asked, 50 in the example.

NS = Code number shift. In the example = 9, i.e. the first student paper will be code 9, and the rest will follow in numerical order. The example is code nr.20.

NSR = Random number shift. In the example = 13, i.e. the random number string will be advanced 13 along the string beginning with the initial number 3125 (as set in program at card 54).

NMS = Number of Master copies desired, 1 in the example.

JN = Renumber control. If 0 or blank the question numbers will be scrambled from copy to copy. Any other entry will inhibit this scramble.

JT = Text scramble control. If 0 or blank the text will be progressively scrambled at each %% entry. Any value other than 0 or blank will inhibit this scramble.

Format is 7I5, i.e. the values above must be right adjusted to columns 5, 10, 15, 20, 25, 30, 35.

Cards 241-290: Text cards, as punched by data center with question numbers (**01**, etc.) in place of answers. There must be 50 cards. Those in excess of text are simply blank cards. LQ(4000) = the text array, 50 cards of Format 80A1.

Cards 291-340: Answer cards. The question number corresponding to this answer is of Format I2, i.e. must be right adjusted to column 2. The answer follows in Format 20A1, i.e. any 20 characters. These are extracted from the circled text given by the instructor. At each circled location the data center extracts the question number for columns 1, 2 and the answer (up to 20 spaces) for columns 3-22.

LAA(50) = The question number, up to 50 questions.

LA(50,20) = The answer array, up to 50 answers of up to 20 characters each.

Cards 335-340: Where a numerical answer is desired that is to be computed by the student, LAA remains as above. LA is inserted as the phrase NUMERICAL ANSWER, or FIGURE CHOICE, and these legends will appear on the student paper in place of the usual verbal answer. In order to invoke this function the variable LNA(50) must be inserted after LA. LNA is the correct numerical answer, any combination of digits up to 99999. Format is I5, i.e. LNA must be right adjusted to column 27. Thus, LNA may represent an arithmetically computed answer, as on cards 335-338. Or, it may represent a choice number from graphical or other material supplied by the instructor.

Card 341: Name list. Up to 200 student names may be entered here, on separate cards. These will appear in place of the dashes given after NAME = at the top of the example. NAME(200,40) in Format 40A1, i.e. 40 spaces are allowed for each student name. If the number of copies requested, NSTUD, is greater than the number of student name cards supplied, the additional copies will be printed without name, as in the example.

Card 342: An obligatory blank card, which signals termination of the data set, and of the run.

Section 4: Program Modifications and Discussion:

In the program shown in Figure 2, the random numbers are truncated to four digits before being used as answer codes. Thus, by chance, the same four digit code will appear twice on about one student's paper out of a hundred. We have found that it is simplest to ignore this effect, and to instruct the student to simply use the answer codes as if no duplicate existed on his paper. At worst, this would allow the student to have these two answers interchanged and "incorrect," and still receive credit for each. However, even this possibility is extremely unlikely, since such pairs occur with only random correlation to answers, when they occur at all. If the user felt that this remote possibility was, nonetheless, unsettling, the program could be modified by storing the random answer codes for each student's sheet while that sheet was being produced (i.e., in the loop from card 216 to card 225 of Figure 2). An additional check loop could be inserted here and, if a duplicate answer code were detected, it could be rejected and the random sequence advanced one in compensation.

The random number generator itself is of the congruential type^{4,7} adapted, in this case, to the 32-bit word of the IBM-360/370 systems. It is shown on cards 105-107 of Figure 2, with the initial value set at card 54. Modifications to fit other word types are given in the literature.^{4,7}

The test format shown in Figure 1 may be changed quite simply by changing array dimensions and the corresponding FORMAT statements. In all, 100 spaces are presently allowed for text and answer on each line in what might be called an 80 + 20 format, i.e., 80 spaces for text and 20 for answers.

A different apportionment is obtained as follows:

1. Let the new number of allowable spaces per answer = NA.
2. Then $NQ = 100 - NA$, where NQ is the number of characters available for text.
3. Then the total text array size must be $50 * NQ$, since there are 50 lines available.
4. Whereupon the following changes are to be made on cards 25, 38, 40, 97, 98, 112, 125, 188, 192, 193, 194, 229, 230:
 - 20 is replaced by NA
 - 80 is replaced by NQ
 - 3999 is replaced by $(50 * NQ) - 1$
 - 4000 is replaced by $(50 * NQ)$

Making these changes, for example, one could render each line of text a short question in its own right with, as needed, fairly long answers. Or, similarly, one could use a 50-50 format for a matching type of test where each entry in the first column of ≤ 50 characters was to be matched to one of the entries in the second column of ≤ 50 characters.

Should the number of names in the allowed name list exceed 200, it is only necessary to change the 200 dimension of the NAME (200,40) array on card 24 to the desired value.

Finally, the entire width used may be decreased, say to the 8-1/2 inches of a standard 8-1/2 x 11 sheet. 8-1/2 inches corresponds to 85 characters on a standard printer. At present, a total width of 130 characters is employed, 100 for text and answer, and the remaining 30 for spaces, codes, etc. At 85 total, this would leave 55 characters for text + answer, and this could be accommodated by the system outlined above with 55 replacing the 100. The present vertical size is 11 inches, so no change would seem to be indicated there. However, this 11 inches utilizes 60 lines vertically,

10 for heading, etc., and 50 for text + answer. Thus, modification vertically would only require substitution of the 50 used in the system outlined above by the desired number of lines.

FIGURE LEGEND

Figure 1: Sample examination, from a course in neoplasms using Robbins⁵ and Ackerman¹ as texts. A student copy is shown, before removal of the correction strip (far right). The first 40 questions are of the straight-text type, and the last 10 are referred to tabular/graphical material handed out as reproduced sheets, or placed on the blackboard. Questions 03, 06, 07, and 10 are of the numerical-answer type. Both paragraph order and question-number order were scrambled, in this particular example, independently of one another. Thus, another student would receive a copy with paragraphs different from these, and question numbers also different, even for the same text sentences.

PATH542, NEOPLASMS 2/22/73

NAME= _____

CODE = 20

20

	CHOICE	AND	CODE.	QX #, & CODE.	
BRONCHOGENIC CARCINOMA IS **11** AMONG THE GREAT VARIETY OF TUMORS OF THE LUNG. THERE IS A DIRECT CORRELATION BETWEEN THE FREQUENCY OF LUNG CANCER AND: (1) THE AMOUNT OF **12** (2) THE TENDENCY TO **13** (3) THE DURATION OF THE **14**. IN SMOKERS, THE EPITHELIAL CHANGES OBSERVED IN THE LINING OF THE RESPIRATORY TRACT ARE: LOSS OF **15** CELLS; **16** CELL HYPERPLASIA, SQUAMOUS METAPLASIA, AND ATYPIA OF CELLS. PULMONARY CANCER HAS NOT BEEN INDUCED IN ANY EXPERIMENTAL ANIMAL BY DIRECT EXPOSURE TO **17** OR TO **18** SMOKE. BRONCHOGENIC CARCINOMAS ARISE MOST OFTEN IN AND ABOUT THE **19**. IN ALL INSTANCES A PRIMARY MUCOSAL LESION MAY BE FOUND WITHIN THE **20**. HISTOLOGICALLY, BRONCHOGENIC CARCINOMAS ARE DIVIDED INTO: (1) **21**, 70%; (2) **22**, 10%; (3) **23**, 20%. THE UNDIFFERENTIATED LESIONS ARE THE MOST **24** OF ALL FORMS AND HAVE THE POOREST **25**. THE MAJOR CLINICAL PRESENTING COMPLAINTS ARE: (1) **26**, 75%; (2) **27**, 40%; (3) CHEST PAIN, 40%; AND (4) **28**, 20%. SCATTERED REPORTS HAVE INDICATED A CURIOUS ASSOCIATION BETWEEN BRONCHOGENIC CARCINOMA AND CERTAIN **29**, PARTICULARLY **30** AS WELL AS GYNECOMASTIA.	ADENOCARCINOMA		3231	1-----	8130
	ADENOMATOSIS		2548	2-----	4636
	BASAL		968	3-----	51
	BEHAVIOR		1790	4-----	6602
	BRONCHIAL ADENOMA		5079	5-----	2968
	BRONCHOGENIC CA.		4636	6-----	16
	BRONCHUS		3474	7-----	65000
	BY-PRODUCTS		6904	8-----	3
	CILIATED		1642	9-----	5
	COUGH		7936	10-----	10
	CUSHING'S SYNDROME		810	11-----	5406
	DAILY SMOKING		7637	12-----	7837
	DYSPNEA		636	13-----	4317
	ENDOCRINE DISEASES		7791	14-----	77
	EXTRACTS OF TOBACCO		4226	15-----	1842
	HILUS OF THE LUNG		2246	16-----	968
	INHALE		4917	17-----	4045
	INTRALUMINAL GROWTH		215	18-----	4226
	LUNG AND BREAST		7765	19-----	2246
	LYMPHOEPITHELIOMA		5483	20-----	3474
	MALIGNANT NEOPLASMS		263	21-----	2365
	MESOTHELIOMA		5785	22-----	3231
	METASTASIZE		5310	23-----	423
	ONLY SLIGHTLY		6602	24-----	7069
	PAPILLOMA		2439	25-----	5483
	PLASMA CELL		282	26-----	7936
	PLASMACYTOMAS		5913	27-----	5622
	POLYPS		5644	28-----	636
	POLYPS OF THE LARYNX		2864	29-----	7791
	POOR		2968	30-----	810
	PROMINENT		5406	31-----	2548
	PROGNOSIS		5483	32-----	7790
	RAPIDLY GROWING		7069	33-----	5079
	RESPIRATORY SYSTEM		8130	34-----	263
	SECONDARY METASTATIC		3388	35-----	215
	SMOKING HABIT		77	36-----	5310
	SQUAMOUS		1286	37-----	6983
	SQUAMOUS CELL		2565	38-----	6904
	SUBSEROSA		7220	39-----	3388
	TOBACCO SMOKE		4045	40-----	7220
	TRANSITIONAL CELL		1790	41-----	5785
	UNDIFFERENTIATED		423	42-----	1755
	WEIGHT LOSS		5622	43-----	1286
	5-HYDROXYTRYPTAMINE		6983	44-----	2864
	NUMERICAL ANSWER		0	45-----	5844
	NUMERICAL ANSWER		0	46-----	2439
	NUMERICAL ANSWER		0	47-----	5913
	NUMERICAL ANSWER		0	48-----	282
	FIGURE CHOICE, NR. =		0	49-----	1790
	FIGURE CHOICE, NR. =		0	50-----	5483

FIGURE LEGEND

Figure 2: Listing of program (cards numbered 1-236), and of the sample data set (cards 237-342) used to generate the example of Figure 1.

TITLE CARD: QUIZ50S LISTING

PAGE NR. 1

NR.

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1 **** JOB CONTROL CARDS HERE, PRECEDING FORTRAN
2 C** PROGRAM QUIZ50S, QUIZ SCRAMBLER, 50/20 OPTION, 26 FEB 1973.
3 C
4 C** FIRST A LIST OF SYMBOLS, A QUIZ LEGEND, & QUIZ IDENTIFIER ARE READ IN
5 C** THEN RUN CONTROL CODES (SEE BELOW) ARE READ IN.
6 C** 50 TEXT CARDS MUST BE READ IN, EVEN IF THE 50 IS PADDED OUT WITH BLANKS.
7 C CARDS ARE STRAIGHT TEXT, 80 COLS/CARD, USING ANY SYMBOL COMBINATIONS EXCEPT
8 C // OR /* (WHICH MIGHT INTERFERE WITH JCL). QUESTION NUMBERS ARE INDICATED
9 C BY PAIRED *, I.E. **01**, ETC. %% IS USED ANYWHERE IN THE TEXT TO INDICATE
10 C TEXT SCRAMBLE POINTS. UP TO 50 %% MAY BE USED. HOWEVER, TO AVOID BROKEN
11 C SENTENCES IN THE STUDENT OUTPUT, %% SHOULD USUALLY BE PLACED AT THE END
12 C OF COMPLETE SENTENCES.
13 C
14 C** THEN, ANSWER CARDS ARE READ IN, IN ALPHABETICAL ORDER, THE QX NR SHOULD BE
15 C IN COLS 1&2, AND THE ANSWER TEXT STARTING IN COL 3, BUT NOT EXTENDING PAST
16 C COL 22. THERE SHOULD BE AS MANY ANSWER CARDS AS THE VALUE OF NQX UN CONTROL
17 C CARD.
18 C** IF IT IS DESIRED TO SUBSTITUTE A STUDENT-CALCULATED, NUMERICAL, ANSWER FOR
19 C THE RANDOM CODE, IT MAY BE ENTERED AS A RIGHT-ADJUSTED, INTEGER, NUMBER
20 C IN COLS 23-27 OF THE ANSWER CARD. ANY LEGEND MAY THEN BE USED IN COLS 3-22,
21 C E.G. 'NUMERICAL ANSWER', OR 'FIGURE CHOICE, NR. = '.
22 LOGICAL*1 LQ, LA, MM, LSF1, LSF2, LQM, NBR
23 DIMENSION LD(5), LAA(50), LAB(50), LCOD(50), LP(40), LBM(50), LB(50),
24 1 NAME(200,40),
25 ILNA(50), LAAD(50), LE(12), LQ(4000), LQM(4000), LA(50,20), MM(10)
26 10 FORMAT(5X, ' CHOOSE THE *BEST* ANSWER FOR EACH QUESTION, AND COPY I
27 ITS CODE SYMBOL INTO THE SPACE PROVIDED BESIDE THE QUESTION', 6X, 6A1
28 2 )
29 11 FORMAT(1H0)
30 12 FORMAT(1H1)
31 13 FORMAT(6H GRIEF)
32 14 FORMAT(5X, 40A1, 'NAME= ', 40X, 'CODE =', 15, 5X, 15)
33 15 FORMAT(5X, ' NUMBER. USE PENCIL, AND WRITE CODE CLEARLY INTO SPACE B
34 15(IDE QUESTION NR.', 46X, 5A1)
35 16 FORMAT(84X, 'CHOICE AND CODE. QX #, & ')
36 17 FORMAT(80A1, 15)
37 18 FORMAT(1615)
38 19 FORMAT(1X, 80A1, 3X, 20A1, 15, 3X, 13, 5A1, 5X, 15)
39 20 FORMAT(5X, 10I12)
40 21 FORMAT(12, 20A1, 15)
41 22 FORMAT(114X, 'CODE. ')
42 23 FORMAT(5X, ' MASTER COPY ', 4I10)
43 24 FORMAT(5X, 40A1, 'NAME=', 2X, 40A1, 17X, 'CODE=', 15, 5X, 15)
44 27 FORMAT (80A1)
45 28 FORMAT (5X, 80A1)
46 29 FORMAT (5X, 12, 20A1)
47 C** READ SYMBOL CARD, USUALLY '0123456789* Z-----'
48 READ 27, MM, LSF1, NBR, LSF2, LD
49 231 CONTINUE
50 DO 37 J=1, 200

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PAGE NR. 2

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NR.
51      DO 37 K=1,40
52      37 NAME(J,K)=NB
53      LL=0.0
54      JXX=3125
55      LST=2**18
56      DO 70 N=1,50
57      70 LAA(N)=0
58      NBR=NB
59      DO 69 K=1,50
60      LNA(K)=0
61      DO 69 J=1,20
62      LA(K,J)=NB
63      69 CONTINUE
64 C** READ TEST LEGEND, AND ANSWER LIST IDENTIFIER. THEN READ RUN CONST.
65 C** NSTUD=# COPIES, NQX=# ANSWERS, NS=CODE SHIFT, NSR=RANDOM NR SHIFT.
66 C   NMS=# OF MASTER COPIES TO BE PRINTED, JN/JT=CONTROL OF NUMBER/TEXT SHIFT
67 C   OPTIONS (SEE BELOW).
68     READ (5,17,END=230) LP,LE
69     READ 18, NSTUD,NQX,NS,NSR,NMS,JN,JT
70     IF(NMS.LE.0) NMS=3
71     IF(NS.LE.0) NS=15
72 C** READ IN TEXT CARD ARRAY (LQ), & ANSWER CARD ARRAY (LAA/LA/LNA).
73     READ 27,LQ
74     DO 110 K=1,NQX
75     110 READ 21, LAA(K),(LA(K,J),J=1,20),LNA(K)
76     DO 30 J=1,200
77     READ 17,(NAME(J,K),K=1,40)
78     IF (NAME(J,1).EQ.NB) GO TO 31
79     30 CONTINUE
80     31 CONTINUE
81     IF(NSR.LE.0) NSR=13
82 C** PRINT NMS MASTER COPIES, WITH ANSWERS ORDERED BY QUESTION NUMBER.
83     NY=0
84     DO 130 K=1,NMS
85     PRINT 12
86     PRINT23, NSTUD,NQX,NS,NSR,NMS,JN,JT
87     PRINT 11
88     PRINT 28, LP,LE
89     DO 122 L=1,50
90     LB(L)=0
91     LBM(L)=0
92     DO 116 N=1,50
93     IF(LAA(N).EQ.L) GO TO 120
94     IF(LAA(N).EQ.0) GO TO 120
95     116 CONTINUE
96     120 NZ=NY+1
97     NY=NY+80
98     IF(NY.GT.4000) GO TO 128
99     122 PRINT 19,(LQ(J),J=NZ,NY),(LA(N,M),M=1,20),LNA(N),L,{LD(MN),MN=1,5)
100     1,N

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PAGE NR. 3

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NR.
101 128 NY=0
102 130 CONTINUE
103 C** SHIFT RANDOM NUMBER CHAIN ALONG BY NSR
104 DO 140 K=1,NSR
105 JXX=JXX*65547
106 IF(JXX) 145,140,140
107 145 JXX=JXX+2147483647+1
108 140 CONTINUE
109 C** LOCATE,STORE,& BLANKOUT, THE TEXT SHIFT LOCATIONS (%%).
110 KB=0
111 KBM=0
112 DO 300 LF=1,4000
113 IF(LQ(LF).EQ.LSF2) GO TO 301
114 GO TO 300
115 301 IF(LQ(LF+1).EQ.LSF2) GO TO 302
116 GO TO 300
117 302 KB=KB+1
118 LBM(KB)=LF
119 LQ(LF)=NBB
120 LQ(LF+1)=NBR
121 300 CONTINUE
122 C** LOCATE , AND STORE, THE QUESTION NUMBER LOCATIONS (**NR**).
123 KA=0
124 KKK=0
125 DO 100 KK=1,4000
126 IF(KK.LE.KKK) GO TO 100
127 IF(LQ(KK).EQ.LSF1) GO TO 101
128 GO TO 100
129 101 IF(LQ(KK+1).EQ.LSF1) GO TO 102
130 GO TO 100
131 102 KA=KA+1
132 KAA=KA
133 LB(KA)=KK+2
134 KKK=KK+5
135 100 CONTINUE
136 C** PRINT SYMBOLS USED, & ARRAYS FOR LOCATIONS OF %, **, & NUM. ANS.
137 PRINT 12
138 PRINT 28,MM,LSF1,NB,LSF2,LO
139 PRINT 11
140 PRINT 20, LBM
141 PRINT 11
142 PRINT 20, LB
143 IF(LB(NGX).GT.0) GO TO 103
144 PRINT 13
145 STOP 998
146 103 PRINT 11
147 PRINT 20, LNA
148 NF=NSTUD + NS
149 C** BEGIN ASSEMBLY OF COMPLETE QUIZZES.
150 DO 200 L=NS,NF

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NR.
151      DO 66 K=1,50
152      LCOB(K)=0
153      LAB(K)=0
154      66 CONTINUE
155      IF(JN.NE.0) GO TO 71
156 C** BEGIN NUMBER SHIFT, IF JN.NE.0.
157      DO 67 K=1,NQX
158      LAAP=LAA(K)+L*NS
159      65 IF(LAAP-51) 63,64,64
160      64 LAAP=LAAP-50
161      GO TO 65
162      63 CONTINUE
163      LAAD(K)=LAAP
164      67 CONTINUE
165      DO 68 KA=1,KAA
166      NQ=NS*L+KA
167      62 IF(NQ-51) 60,61,61
168      61 NQ=NQ-50
169      GO TO 62
170      60 CONTINUE
171      NT=NQ/10
172      ND=NQ-NT*10
173      LC=LB(KA)
174      71 CONTINUE
175      IF(JT.NE.0) GO TO 400
176 C** BEGIN TEXT SHIFT , IF JT.NE.0.
177      LQ(LC)=MM(NT+1)
178      LQ(LC+1)=MM(ND+1)
179      68 CONTINUE
180      IF(K9.EQ.0) GO TO 400
181      KBM=KBM+1
182      352 IF(KBM.LE.KB) GO TO 351
183      KBM=KBM-KB
184      GO TO 352
185      351 IF(LBM(KBM).LE.0) GO TO 400
186      ND=LBM(KBM)
187      NE=ND-1
188      NG=4000-NE
189      NH=NG+1
190      DO 360 KC=1,NG
191      360 LQM(KC)=LQ(KC+NE)
192      IF(NG.EQ.3999) LQM(4000) = LQ(1)
193      IF(NH.GE.4000) GO TO 400
194      DO 362 KC=NH,4000
195      362 LQM(KC)=LQ(KC-NG)
196      400 CONTINUE
197 C** PRINT COMPLETE QUIZ SHEET.
198      PRINT 12
199      PRINT 10, (LE(MN),MN=1,6)
200      PRINT 15, (LE(MN),MN=7,12)

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NR.
201      PRINT 11
202      LL=LL+1
203      IF(LL-50) 33,33,34
204      33 CONTINUE
205      IF (NAME(LL,1).EQ.NB) GO TO 34
206      PRINT 24, LP,(NAME(LL,KZ),KZ=1,40),L,L
207      GO TO 35
208      34 CONTINUE
209      PRINT 14, LP,L,L
210      35 CONTINUE
211      PRINT 11
212      PRINT 16
213      PRINT 22
214      DO 210 K=1,NQX
215      LM=LAAD(K)
216      JXX=JXX*65547
217      IF(JXX) 205, 206, 206
218      205 JXX=JXX+2147483647 + 1
219      206 LCOD(K)=JXX/LST
220      IF(LCOD(K).LE.0) LCOD(K)=1
221      LAB(LM)=LCOD(K)
222      IF(LNA(K).EQ.0) GO TO 210
223      LCOD(K)=0
224      LAB(LM)=LNA(K)
225      210 CONTINUE
226      LTF=0
227      DO 220 K=1,50
228      LTS=LTF+1
229      LTF=LTF+80
230      IF (LTF.GT.4000) GO TO 200
231      220 PRINT 19,(LQM(J),J=LTS,LTF),(LA(K,M),M=1,20),LCOD(K),K,
232      1      (LC(MOP),MOP=1,5),LAB(K)
233      200 CONTINUE
234      GO TO 231
235      230 STOP 999
236      END
237      *** JOB CONTROL CARDS HERE, FOLLOWING FORTRAN & PRECEEDING DATA.
238      0123456789* *-----
239      PATH542,NEOPLASMS
240      15 50 9 13 1
241      P542 73F11

```

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241  %%BRONCHOGENIC CARCINOMA IS **01** AMONG THE GREAT VARIETY OF TUMORS OF THE
242  LUNG. THERE IS A DIRECT CORRELATION BETWEEN THE FREQUENCY OF LUNG CANCER AND:
243  (1)THE AMOUNT OF **02**;(2) THE TENDENCY TO **03**; AND(3) THE DURATION OF THE *
244  *04**. IN SMOKERS,THE EPITHELIAL CHANGES OBSERVED IN THE LINING OF THE RESPIRATO
245  RY TRACT ARE: LOSS OF **05** CELLS; **06** CELL HYPERPLASIA, SQUAMOUS METAPLAS
246  IA, AND ATYPIA OF CELLS. PULMONARY CANCER HAS NOT BEEN INDUCED IN ANY EXPERIMEN
247  TAL ANIMAL BY DIRECT EXPOSURE TO **07** OR TO **08** SMOKE.%%BRONCHOGENIC CARCIN
248  OMAS ARISE MOST OFTEN IN AND ABOUT THE **09**,%IN ALL INSTANCES A PRIMARY MUCOS
249  AL LESION MAY BE FOUND WITHIN THE **10**,%HISTOLOGICALLY, BRONCHOGENIC CARCINOM
250  AS ARE DIVIDED INTO:(1)**11**, 70%;(2)**12**, 10%; (3)**13**, 20%.THE UNDIFFEREN

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NR.

251 TIATED LESIONS ARE THE MOST **14** OF ALL FORMS AND HAVE THE POUREST **15**. THE
 252 MAJOR CLINICAL PRESENTING COMPLAINTS ARE: (1) **16**, 75%; (2) **17**, 40%; (3) CHEST
 253 PAIN, 40%; AND (4) **18**, 20%. SCATTERED REPORTS HAVE INDICATED A CURIOUS ASSOC
 254 IATION BETWEEN BRONCHOGENIC CARCINOMA AND CERTAIN **19**, PARTICULARLY **20**, AS
 255 WELL AS GYNECOMASTIA.

256 % INCREASING NUMBERS OF CASES OF SO-CALLED PULMONARY **21** HAVE BEEN IDENTIFIED
 257 IN MAN, WITH UNMISTAKABLE EVIDENCE OF CANCEROUS **22**. THE TERM **23** IS SOM
 258 E THING OF A MISNOMER, SINCE THESE TUMORS, ALTHOUGH SLOWLY GROWING, ARE FREQUENT
 259 LY INVASIVE LOCALLY. THEY ARE BETTER CONSIDERED **24** OF LOW AGGRESSIVENESS. %
 260 THE CLINICAL MANIFESTATIONS OF BRONCHIAL ADENOMAS EMANATE FROM THEIR **25**, TH
 261 EIR CAPACITY TO **26** AND THE ABILITY OF SOME OF THESE LESIONS TO ELABORATE **2
 262 7**. PERSISTENT COUGH, HEMOPTYSIS, BRONCHIECTASIS, EMPHYSEMA, AND ATELECTASIS AR
 263 E ALL **28** OF THE INTRALUMINAL GROWTH OF THESE LESIONS.

264 % IN THE PLEURA, **29** INVOLVEMENT IS FAR MORE COMMON THAN **30**. THE ONLY PRI
 265 MARY MALIGNANT TUMOR IS DESIGNATED AS A **31**. THE MOST COMMON METASTATIC MALI
 266 GNANCIES OF THE PLEURA ARISE FROM PRIMARY NEOPLASMS OF THE **32**. %

267
 268 THE MALIGNANT NEOPLASMS OF THE LARYNX ARE ALMOST INVARIABLY **33** CELL CARCIN
 269 OMAS. **34** ARE SMOOTH, ROUNDED, SESSILE OR PEDUNCULATED NODULES THAT RARELY E
 270 XCEED 1 CM. IN DIAMETER, AND OCCUR MOST OFTEN ON THE TRUE VOCAL CORDS. **35** A
 271 RE NOT TRUE NEOPLASMS, WHEREAS THE **36** IS A TRUE NEOPLASM, THAT GROWS AS A SOF
 272 T, FRIABLE, EXCRESCENCE OR NODULE, USUALLY UPON THE TRUE VOCAL CORDS. %

273 ISOLATED **37** MAY ARISE IN THE LYMPHOID STRUCTURES ADJACENT TO THE NOSE AND
 274 SINUSES. THESE PLASMACYTOMAS MAY OCCUR AS APPARENTLY ISOLATED TUMORS UNRELAT
 275 ED TO SYSTEMIC **38** NEOPLASIA.

276 THE **39** CARCINOMA IS CHARACTERIZED HISTOLOGICALLY BY STRANDS AND MASSES OF
 277 POLYGONAL OR SPINDLE CELLS GROWING WITHIN A FIBROUS STROMA. IN MANY OF THESE GR
 278 OWTHS THERE IS AN ABUNDANT LYMPHOID INFILTRATE WITHIN THE FIBROUS STROMA, DESIGN
 279 ATED, THEN, AS A **40**.

280 % FROM FIGURE 'A' THE MOST COMMON SITE OF VISCERAL MALIGNANCY IN WESTERN MALES I
 281 S THE **41**, WITH **42** DOMINATING THE MALIGNANT MORTALITY AT THIS SITE. CURRE
 282 NT U.S. MALE, WHITE, MALIGNANT MORTALITY AT THIS SITE IS ABOUT **43**/100,000/YR.,
 283 WITH AN INCIDENCE **44** HIGHER, INDICATIVE OF A **45** CURE RATE. FURTHERMORE,
 284 THE U.S., WHITE, MALE MORTALITY RATE AT THIS SITE IS RISING AT A RATE OF ABOUT

285 **46**/MILLION/YR., SO THAT ONE MAY ANTICIPATE A TOTAL MALIGNANT MORTALITY AT TH
 286 IS SITE OF ABOUT **47**/YR. FOR THE POPULATION OF 100 MILLION WHITE MALES EXPECT
 287 ED IN 1975. % FROM FIGURE 'B' THE STRUCTURAL FORMULA OF THE COMPOUND ASSOCIATED
 288 WITH THE CARCINOID SYNDROME OF SOME BRONCHIAL ADENOMAS IS **48**, WHILE THAT OF
 289 ITS URINARY METABOLITE IS **49**. A URINARY LEVEL OF **50** MGM. % MAY BE CONSTI
 290 DERED DIAGNOSTICALLY SIGNIFICANT FOR THIS METABOLITE.

291 12ADENOCARCINOMA

292 21ADENOMATOSIS

293 06BASAL

294 22BEHAVIOR

295 23BRONCHIAL ADENOMA

296 42BRONCHOGENIC CA.

297 10BRONCHUS

298 28BY-PRODUCTS

299 05CILATED

300 16COUGH

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NR.

301 20CUSHING'S SYNDROME

302 02DAILY SMOKING

303 18DYSPNEA

304 19ENDOCRINE DISEASES

305 08EXTRACTS OF TOBACCO

306 09HILUS OF THE LUNG

307 03INHALF

308 25INTRALUMINAL GROWTH

309 32LUNG AND BREAST

310 40LYMPHOEPITHELIOMA

311 24MALIGNANT NEOPLASMS

312 26METASTASIZE

313 31MESOTHELIOMA

314 44ONLY SLIGHTLY

315 36PAPILLOMA

316 37PLASMACYTOMAS

317 38PLASMA CELL

318 34POLYPS OF THE LARYNX

319 35POLYPS

320 45POOR

321 01PREEMINENT

322 30PRIMARY MALIGNANCY

323 15PROGNOSIS

324 14RAPIDLY GROWING

325 41RESPIRATORY SYSTEM

326 29SECONDARY METASTATIC

327 04SMOKING HABIT

328 11SQUAMOUS CELL

329 33SQUAMOUS

330 07TOBACCO SMOKE

331 39TRANSITIONAL CELL

332 13UNDIFFERENTIATED

333 17WEIGHT LOSS

334 275-HYDROXYTRYPTAMINE

335 43NUMERICAL ANSWER 57

336 46NUMERICAL ANSWER 16

337 47NUMERICAL ANSWER 65000

338 50NUMERICAL ANSWER 10

339 48FIGURE CHOICE, NR. = 3

340 49FIGURE CHOICE, NR. = 5

341 NAME LIST HERE

342

FIGURE LEGEND

**Figure 3: Program flow Diagram, with statements keyed to the card numbers
of Figure 2.**

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